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ABSTRACT

This circular provides information to assist in assessing the pollution potential of liquid wastes from parlors and milkhouses. Approaches to resolving problems through stabilization lagoons, irrigation, and tank collection as mandated in statutory authority are discussed. (CS)

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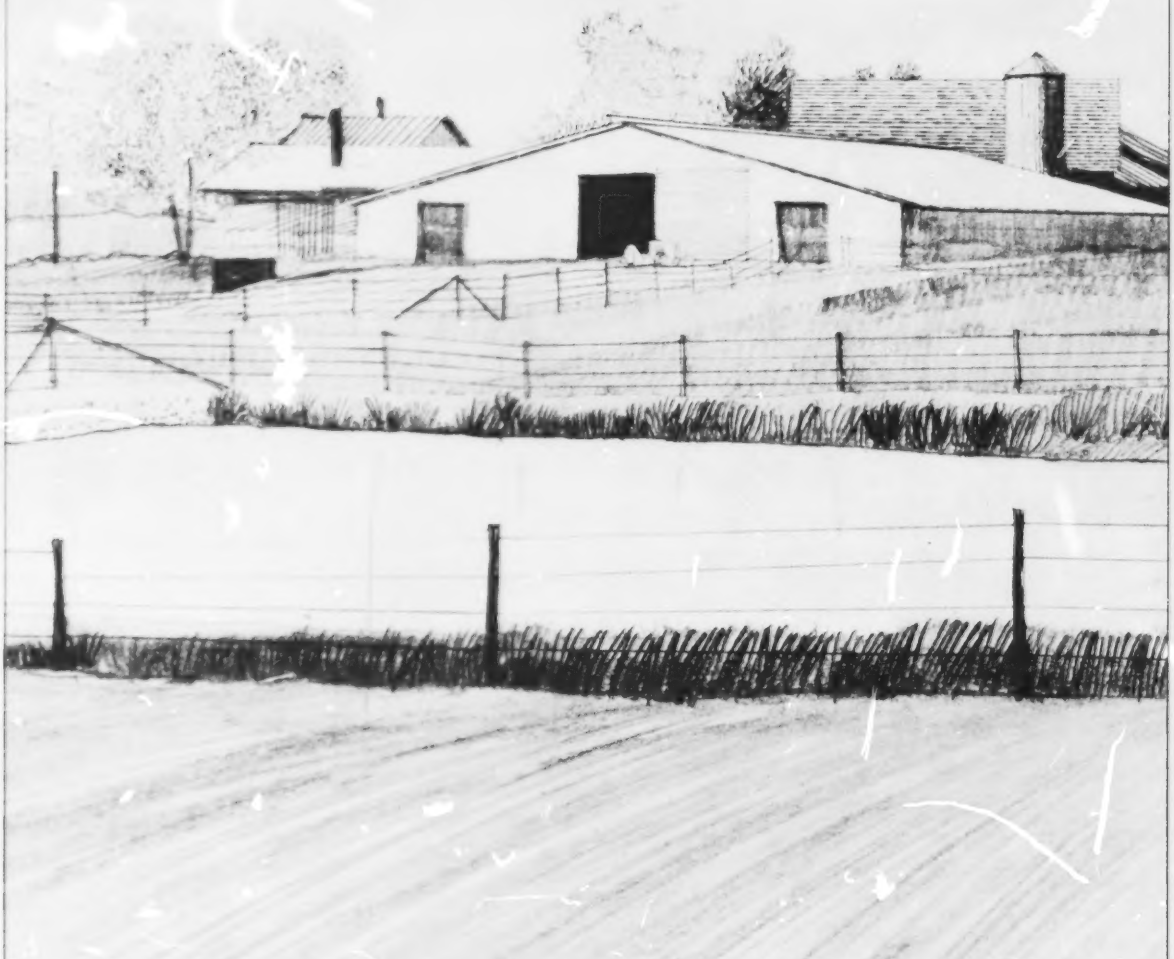

Special Circular 154

Disposal of Liquid Wastes from Parlors and Milkhouses

The Pennsylvania State University
College of Agriculture Extension Service
University Park, Pennsylvania

SE 023 979

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WASTE DISPOSAL REGULATORY AUTHORITY

The Pennsylvania Department of Environmental Resources (DER) is the executive agency responsible for the rules, regulations, and enforcement procedures pertaining to disposal of liquid waste, and the abatement of water-polluting activities. The statutory authority for this responsibility is the CLEAN STREAMS LAW of Pennsylvania as amended.

Waste water disposal permit

The Clean Streams Law indicates that a *waste water disposal permit* is required, and must be obtained prior to the construction or installation of any type of waste-treatment facility that:

1. will discharge effluent (water) to the surface or underground waters of the Commonwealth, or
2. creates a danger of polluting the waters, or
3. may be necessary for effective regulation of the facility even though it does not have a direct discharge.

Landowner responsibility

The law indicates specifically that the landowner or land occupier is the person responsible for obtaining the waste water disposal permit, and if he ignores this responsibility and violates the law he must suffer the consequences.

If there is any question as to whether a waste water permit will be required for a specific waste-disposal facility, the person concerned should write to the regional sanitary engineer for the Pennsylvania Department of Environmental Resources for an opinion. The letter should indicate:

1. whether liquid waste will be discharged into a stream or other body of water,
2. type or description of the waste and an estimate of the quantity to be discharged per day,
3. location of the waste-producing facility,
4. type of soil on which the facility will be constructed, (as determined from the county soil survey report), and
5. method of effluent disposal, including final treatment if such is contemplated.

Agricultural waste disposal permit

Although a waste water disposal permit must be obtained for the operation of all industrial waste disposal facilities, the Department of Environmental Resources has ruled that a permit may or may not be required for treatment and disposal of agricultural wastes. It depends on the circumstances in each case. Normally a permit will *not* be required where:

1. the impoundment facility is designed to operate without discharging effluent into the waters of the Commonwealth, and
2. the retention or holding capacity for polluting substances does not exceed 250,000 gallons for a single impounding pond or 500,000 gallons for two or more ponds in a single treatment system, or
3. the Department of Environmental Resources indicates that a permit is not necessary to insure the protection of the Commonwealth's water resources.

Applying for permit

As a rule, an application for a permit must be prepared and submitted by a *Registered Professional Engineer*. It must include maps, drawings, plans, and specifications. Forms and instructions for preparing the application can be obtained from the office of the DER regional sanitary engineer.

Cost-sharing and/or SCS assistance

Any farmer or landowner who expects to apply for USDA cost-sharing assistance for the construction of a waste-management facility can obtain further information from the local Soil Conservation Service (SCS) office. In most instances, Registered Professional Engineers employed by the SCS will prepare the plans and specifications necessary to accompany applications for the permits.

MILKING PARLOR WASTE DISPOSAL

Disposal of liquid wastes from milkhouses and milking parlors is one of the most critical problems facing Pennsylvania dairymen today. New facilities, more automatic milk-handling systems, and clean-in-place (CIP) equipment have greatly increased the amount of water used for cleaning and sanitizing milk-processing equipment. These larger quantities of waste water together with the milk solids are compounding an already difficult waste-disposal problem.

Methods of liquid waste disposal

Various methods and techniques are being tried to find more convenient, economical, and sanitary ways to dispose of liquid wastes. They include (1) waste impounding ponds or waste stabilization lagoons, (2) sprinkler irrigation disposal systems, (3) liquid-manure handling systems, (4) tank collection and spreading systems, and (5) septic tank systems. Any of these methods or combinations of methods may provide a partial solution to the disposal problem. The purpose of this publication is to provide an explanation of each method so that the dairyman who has to find a solution can make a rational choice of the alternatives available to him. The terms waste impounding ponds and stabilization lagoons are synonymous and are used interchangeably throughout this publication.

AGRICULTURAL WASTE STABILIZATION LAGOONS

The agricultural waste impounding pond or stabilization lagoon is a simple, effective, liquid-waste treatment and disposal facility. It is a shallow body of water that receives liquid-waste material from the sewer or main drain and holds it for a period of time during which the organic material undergoes a natural biochemical decomposition process. This process can be either "aerobic — without odor" — or "anaerobic — with odor."

Anaerobic lagoon not acceptable

In an anaerobic lagoon the sewage microorganisms live without oxygen. Decomposition of the organic materials is relatively slow and incomplete and the odor of "rotten eggs" or "swamp gas" released is very objectionable. The odor together with flies, insects, and scum on the surface of the water usually become public nuisances. This type of lagoon is not acceptable for the disposal of milkhouse wastes, and field sanitarians will not approve of its use. For these reasons no further discussion of anaerobic lagoons is included in this publication.

Aerobic lagoons are acceptable

Experience indicates that the aerobic stabilization lagoon is an acceptable, convenient, and economical alternative for the treat-

ment and disposal of milking parlor wastes. The treatment process is very similar to that which takes place in a municipal sewage treatment facility. It includes dilution of the strong liquid wastes, settling of heavy solids, and biochemical oxidation of the organic materials. The biochemical destruction of the sewage is fairly complete and does not create an objectionable odor. Effluent discharged from the lagoon is relatively clear, but it must not be discharged into the waters of the Commonwealth.

Bacteria and other microscopic organisms in an aerobic lagoon consume an abundance of dissolved oxygen in the digestion process. They decompose the organic substances and break them down into simple compounds — primarily carbon dioxide and water. Algae growing in the water use the carbon dioxide to produce more oxygen. This activity known as photosynthesis is a natural biochemical process that takes place only during daylight hours and requires no human assistance. The amount of oxygen produced depends on the intensity of sunlight, the temperature of the water, the area of water surface exposed to the light, and the plant nutrients available in the waste discharged into the lagoon. As long as these conditions are in balance the lagoon will remain in a satisfactory aerobic condition.

Solid waste causes odor

Large quantities of organic wastes such as manure or wasted animal feed should not be flushed into an aerobic lagoon. Too much of these materials may overload the lagoon and exceed its treatment capability — that is, the amount of waste to be digested and the dissolved oxygen available will get out of balance. The aerobic bacteria will not be able to decompose all of the waste material, and the biological activity will change from aerobic to an unsatisfactory anaerobic condition. This change will be accompanied by the traditional odor of sewage or rotten-eggs.

Never dump spoiled milk down a drain that discharges into a lagoon. The amount of oxygen required to decompose milk solids in liquid wastes is tremendous. Even very small quantities of milk may upset the biological balance and cause the lagoon to smell like an open septic tank for weeks at a time.

Planning of waste lagoons

The two most important factors affecting the design of a stabilization lagoon are:

1. The volume or quantity of liquid waste to be treated (gallons per day), and
2. The load of pollutional waste material, expressed in terms of its biochemical oxygen demand (BOD pounds per day).

These two factors used together determine the size and capacity necessary for effective waste treatment.

The number of gallons of liquid waste anticipated per day depends on the type of equipment used in the milk-handling system and how much common sense is applied in the use and reuse of water for rinsing, washing, and sanitizing purposes. The operator of a pipeline system for 60 cows may use two or three times as much water as another operator working with manual equipment, or vice versa. Even with similarly equipped systems one operator may clean and sanitize his equipment just as well as another and yet use only half as much fresh water to do the job.

If the number of cows milked is increased from 60 to 120, or even to 180, the amount of liquid waste attributed to the milking operations will increase somewhat but it will not double or triple that for 60 cows. The data shown in Table 1 may be used as a

guide for planning aerobic lagoons and perhaps certain other dairy waste-disposal facilities. *(See page 12)*

A stabilization lagoon designed to impound the liquid waste from a bulk tank and a 4-unit pipeline milking system in a stanchion barn should have about 3,000 to 4,000 square feet of water surface area. For a double-4 herringbone milking parlor with 4 units and a bulk tank cleaned-in-place, the lagoon should have about 4,000 to 6,000 square feet of water surface.

Processing creates more waste

Milk-processing activities include blending, pasturizing, bottling, and jugging for retail trade. These activities require more equipment, and the cleaning and sanitizing of this equipment will increase both the volume of liquid waste and its pollutional strength. The producer who is in the milk-processing and retailing business will have more of a waste-disposal problem than the one who sells wholesale and ships his milk by tank truck. As a result, a lagoon used in conjunction with a jugging operation or a retail processing center should be about twice as large as a lagoon used for a milking system alone, even if the quantity of milk handled is the same for both operations.

Selection of a site

A dairy-waste lagoon should be about 300 feet from the barn and downwind from the center of operations, to prevent any possible odors from drifting back to the milkhouse. It should be downhill so that the sewer will drain naturally. If the elevation of the only available site is higher than that of the milkhouse then a sewage pump will be required to lift the waste to the lagoon.

The lagoon should be as far away from an existing stream as possible. It must not have the potential capability of polluting the waters of the Commonwealth unless its construction is authorized and regulated by a waste-water disposal permit.

On steep terrain, it may be desirable to locate the lagoon along the contour. A narrow lagoon will be less expensive to construct but it may be more difficult to manage. In some instances it may be necessary to construct two or more small lagoons in order to provide adequate treatment for the expected waste load.

Lagoon must hold water

The site selected for the lagoon must be suitable for constructing a farm pond. The soil should be a dense, impervious material that will prevent seepage through the bottom. Avoid sites that include dry stream beds, gravel pits, fractured shale banks, and sink holes which will not hold impounded water. If the lagoon doesn't hold water, it will not function as it should. Excess seepage of polluted water may become a nuisance and create a hazard to public health. It can contaminate wells, springs, or other local sources of water supply used on the farm or in the home.

Lagoon is built like a farm pond

A sewage lagoon may be round, square or rectangular. It should be constructed like a farm pond except that it should have a flat, level bottom to provide uniform depth. As a rule the water should be at least 3 but not more than 5 feet deep. The breast of the dam and the height of the banks should be at least 3 and preferably 4 or 5 feet above the normal water level, to provide emergency storage.

The banks should be sloped 3 to 1 (3 feet of horizontal run to 1 foot of vertical rise) to prevent the soil from eroding or slipping down into the water.

Emergency spillway

Although the CLEAN STREAMS LAW prohibits the overflow or

discharge of effluent from a lagoon into the waters of the Commonwealth without a permit, it is necessary to provide some means of protecting the dam around the lagoon in case of an emergency or flooding situation.

A flat-bottom channel or spillway should be constructed in the undisturbed solid bank at the anchor end of the dam. The bottom of the channel should be about 4 feet wide and 1 foot below the top of the dam. The entire surface should be seeded with a suitable grass such as K-31 fescue to prevent erosion.

Controlling discharge or overflow

Limit water use In most instances a lagoon can be designed to function without an outlet or normal overflow. The quantity of water used for cleaning and sanitizing milk-handling equipment should be managed to prevent the unnecessary production of liquid waste.

Seepage terrace One of the simplest methods is to construct a shallow, broad-base terrace below the emergency spillway where the terrace can intercept and hold the effluent until it seeps into the soil. Normally the construction of such a terrace will qualify for cost-sharing assistance under the U.S. Department of Agriculture's Rural Environmental Assistance Program (USDA-REAP).

Irrigation disposal An alternate method is to have an irrigation pump and sprinkler system available to remove the excess water and lower the liquid depth of the lagoon to its normal working level. The water can be sprinkled in any convenient area provided that it does not puddle, run off, and pollute the waters of the Commonwealth.

Two or more lagoons If automatic prep stalls are installed after the lagoon is constructed or if the operator uses a larger quantity of water for flushing the floors and gutters, a lagoon designed on the basis of data in Table 1 may not have enough capacity to prevent an overflow. In such case it may be necessary to enlarge the original lagoon or install an additional one.

Drain inlet to lagoon

The main drain from the milkhouse should be buried below the frostline and should enter the impoundment below the normal freezing level of the water. It should terminate near the center of the pool. This will provide more uniform dispersion of the waste material and thus increase the biological activity throughout the lagoon. It should discharge the waste at least 1 foot above the lagoon bottom to keep sediment from plugging the end of the pipe.

In the event that the pipeline into the lagoon cannot be installed below the water level it should be supported about 2 feet above the surface on masonry blocks or on posts driven into the bottom. There should be enough free fall between the end of the pipe and the water to prevent an icicle from plugging the end of the line.

Filling with water

A new lagoon should be filled with water as soon as it is completed to saturate the soil and help overcome the initial seepage loss. Water can be piped from the barn roof, a surface drain, or the farm water system. After the lagoon has been filled, all storm water and excess runoff should be diverted around the lagoon to prevent overflow. In extremely dry weather it may be necessary to add more water from time to time to replace losses due to seepage and evaporation.

It is better to start loading the lagoon with liquid waste during the summer when the water temperature is warm. Bacterial and

other biological organisms that decompose the organic material will be much more active and will have more opportunity to multiply and get established before cold weather arrives.

Handling of solid wastes

All solid waste such as manure, mud, bedding material, and wasted feed that can be scraped from the floors, ramps, and platforms should be dumped into the spreader or manure pit, rather than washed down the drain. Strainer pads, paper towels, glass and plastic bottles, rags, and other refuse should be placed in suitable containers for solid-waste disposal. These materials decompose very slowly and if they are flushed down the drain into the lagoon they usually create unsightly conditions around the water's edge.

Fence is needed around lagoon

A woven wire or five-strand barbed wire fence should be constructed around the lagoon to prevent children and livestock from wading in the water. "No Trespassing" signs indicating that it is a sewage-disposal facility should be posted in conspicuous places.

Maintenance is important

Grass and weeds growing on the banks between the fence and the water's edge should be cut to prevent the lagoon from becoming unsightly, and a potential breeding area for mosquitoes and other insects. Milk sanitarians and public health officials will be more patient and cooperative with operators who maintain neat and sanitary waste-disposal facilities than they will with those who make excuses and try to evade good management practices.

Emergency odor control

During the warm days in late winter and early spring the lagoon may become anaerobic and give off a bad odor. This should not last more than a few weeks but, if it does, sprinkle a few pounds of sodium nitrate or ammonium nitrate over the surface each day for a few days. This treatment will usually add enough oxygen to control the odor until aerobic conditions can develop. If bad odor persists throughout the year, then the lagoon does not have enough capacity for its waste load and it should be enlarged or another lagoon added so that the load can be divided between them.

SPRINKLER IRRIGATION DISPOSAL

The disposal of liquid waste by spreading it on the land is perhaps the most effective and efficient method available to Pennsylvania dairymen. The method of spreading will vary with the quantity of waste involved, the estimated cost of the disposal system, and how much time and labor the farmer is willing to devote to the task.

Spreading the waste by means of a sprinkler irrigation system is a very flexible method and one that is adapted to handling either large or small quantities of waste.

How the irrigation system works

In a typical sprinkler disposal system, the liquid waste is pumped from a central collecting tank through a pipe to a suitable disposal site where it is discharged through a series of irrigation sprinklers. The sprinklers should distribute the liquid like a gentle rain; the solids will be filtered out on the surface and the water will be absorbed by the soil.

Operation during freezing weather

One of the most difficult problems associated with sprinkler disposal systems is that of sprinkler operation during the cold winter

months. The system should be designed and managed so that the water does not freeze on the sprinklers or in the pipe. In an ideal situation the sprinkler lines should be placed on a slope so that they will drain quickly during the "off" period of the operating cycle.

Area to be irrigated

The area selected for the disposal site may be part of a hay field, a little-used pasture, or even a woodlot. Surface runoff from higher elevations should be diverted away from the sprinkled area. A protective vegetative cover will be needed to prevent soil erosion. This cover can be a permanent hay crop, tall fescue, Reed canarygrass, or natural vegetation. If the soil is very well drained, crown vetch makes an ideal protective cover.

Type of pipe

Quick-coupling aluminum pipe, polyethylene tubing, or semirigid plastic pipe can be used for the main line and the lateral sprinkler lines. Plastic pipe should be buried to protect it from gnawing rodents, livestock, and the destructive forces of nature. Sprinklers are usually spaced at intervals of 40 or 60 feet.

Polyvinyl chloride (PVC) or other types of semirigid plastic pipe are available in 20-foot sections with slip-joint or solvent-welded connections. Polyethylene plastic tubing can be obtained in coils but there is not much advantage in buying it this way, especially when the lateral lines will have to be cut every 40 feet to attach the sprinklers.

Selecting the sprinkler heads

Irrigation sprinkler heads designed for frost protection give less trouble during freezing weather, although conventional sprinklers have been used satisfactorily. There are many makes, models, and sizes suitable for this purpose. It makes little difference which sprinkler is used as long as the one selected is capable of operating in freezing temperatures, and the rate of application is matched to the infiltration capacity of the soil. Normally the application rate should not exceed 2/10 inches of rainfall equivalent per hour. This rate can be expected if 5-gallon-per-minute (gpm) sprinklers are placed 40 feet apart on the lateral line and laterals are spaced 60 feet apart. Spacings may be increased for larger sprinklers to provide an equivalent application rate. The total application should not exceed the equivalent of 2 inches of rainfall per week (2 in. per acre = 54,306 gal.).

Sprinklers should be attached to risers that are high enough to spray the liquid above the vegetation. In some cases it may be necessary to fasten the riser to a post to keep it in a vertical position. In wooded areas with low brush, 4- and 5-foot risers have been used satisfactorily.

Requirements for irrigation pump

The pump for the sprinkler system should be self-priming and controlled by a float-activated switch. It must be able to handle liquids containing small amounts of abrasive solids without sustaining damage to the impeller or pump housing. In most situations the pump should be installed in a separate clear-water compartment in the tank to avoid pumping the settled solids. A screen should be used in the suction side of the pump to prevent coarse material from plugging the sprinklers.

An irrigation pump meeting certain predetermined pressure and volume specifications will be required to do the job. A well-pump or a basement sump pump will not be satisfactory for this purpose. The pump must provide enough pressure to overcome (1) pipe friction, (2) the vertical elevation between the tank and

the end of the line (1 pound per square inch of pressure for each 2.3 feet of elevation), and (3) an additional 40 to 50 pounds of pressure per square inch (psi) to operate the 5-gpm sprinklers. A local pump dealer may not have a pump in stock that meets the required specifications, but in most instances he will be able to obtain it from his supplier.

Collection tanks

The tank or sump that collects the drainage from the parlor and milkhouse may be a salvaged steel tank, a large precast septic tank, or a concrete-block tank constructed especially for this purpose. A double-compartment tank or two tanks — one for settling and the other for the pump — will eliminate some problems. The settling tank should have enough capacity to hold the accumulated waste for two or three days in case of an emergency situation or a breakdown of equipment. It should have a manhole opening large enough to permit the removal of the settled solids when necessary. An impounding pond may be used in place of the collection tank.

The selection and installation of the hardware for small irrigation systems is a relatively simple matter. Determine how much waste will be generated per day, and refer to Table 2 to find out how many sprinklers will be required. In most instances all of the equipment needed can be purchased from a local irrigation dealer or farm-supply service center. If the quantity of waste exceeds 2,000 gallons per day, professional assistance should be obtained to aid in the design of the system.

LIQUID MANURE SYSTEM

On farms where manure is handled as a liquid, the waste from the milkhouse-milking parlor can be piped directly into the liquid-manure storage tank. If the manure in the tank has to be diluted so that it can be pumped more readily, the milkhouse waste can help solve this problem. As a rule the tank for the liquid manure should be made about one-tenth larger if it is to provide storage for the milkhouse wastes.

TANK COLLECTION AND SPREADING

In an emergency or as a temporary expedient, the tank-collection and spreading method is an effective way to dispose of milkhouse wastes. A large tank should be installed to collect and hold the waste until it can be hauled away to a disposal area.

Size and type of tank

The size of tank needed depends upon the daily volume of waste and how often the dairyman intends to empty it. Weather and field conditions must be considered; if there are many days or weeks when spreading is impossible, the tank should be large enough to store the quantity accumulated during these periods. Reinforced concrete tanks or steel tanks are satisfactory for this purpose. Some farmers have been able to obtain used fuel tanks or salvaged tanks from railway car repair shops.

Liquid manure spreaders

Several types of pumps and tank-spreader combinations can be used for emptying the storage tank. A small liquid manure pump or a submersible sewage pump can be used for loading a home-made tank wagon or spreader. A commercial vacuum-type liquid

manure spreader with a built-in power-take-off pump will be more satisfactory, but it costs more. In any event, this method of milkhouse-waste disposal is probably the most expensive of the methods available.

SEPTIC TANK SYSTEM

The septic tank and tile disposal-field system has proven to be a very unreliable method of waste disposal for a parlor, milkhouse, or milk-processing plant.

Bacteria cannot break down milk solids

The microorganisms that work in a septic tank are unable to break down and decompose the milk solids and fibrous materials that make up the organic part of milkhouse wastes. The limited retention capacity of the septic tank does not provide enough time for solids to settle out, and unconditioned waste material will pass through the tank and out into the tile disposal field. Grease and undigested solids will seal pore spaces in the soil so that it cannot absorb the effluent. The pressure of sewage in the septic tank will force the effluent in the tile lines to the surface of the disposal field. This will result in wet spots and odors which may become a nuisance and health hazard.

Satisfactory for toilet wastes

A septic tank *should* be installed for the disposal of sewage from washrooms and toilets required for employees and guests visiting in the processing plant. The volume of sewage from these sources is usually very small and the effluent from the septic tank can be disposed of in a subsurface tile drainage field, providing the soil characteristics are suitable for on-lot sewage disposal. Information pertaining to the design, construction, and maintenance of septic tanks can be obtained from your county Extension office.

TABLES

Table 1. Design data and work sheet for aerobic lagoons.

Type of installation and equipment	Liquid waste (gallons per day)	Load factor (BOD-lb. per day)*	Suggested water surface area (sq. ft.)†	Work column for this installation
Pipeline milker — parlor or stall barn				
4 units or less	60 to 100	0.5 to 1.0	1,000 to 2,000	
6 to 10 units	90 to 150	0.6 to 1.2	1,200 to 2,400	
12 to 20 units	180 to 300	0.9 to 1.8	1,800 to 3,600	
Bulk tank and milkhouse floor				
1 tank — under 1,000 gal.	20 to 40	0.2 to 0.5	400 to 1,000	
1 tank — over 1,000 gal.	30 to 40	0.3 to 0.6	750 to 1,200	
2 tanks	50 to 80	0.5 to 1.1	1,000 to 2,200	
Milking parlor — side opening				
4 stalls or less	50 to 100	1.0 to 1.5	2,000 to 3,000	
4 to 8 stalls	75 to 150	1.5 to 3.0	3,000 to 6,000	
Milking parlor — double herringbone				
4 to 8 stalls	50 to 100	1.5 to 3.0	3,000 to 6,000	
10 to 20 stalls	100 to 200	2.0 to 4.0	4,000 to 8,000	
20 to 40 stalls	200 to 400	4.0 to 8.0	10,000 to 16,000	
Automatic prep stalls	2 to 6 per cow	____ to ____‡		
Holding area and free stalls	Discharge of washdown waste to aerobic lagoons *is not recommended.*			TOTAL ____

* Best estimate based on field studies and laboratory analyses.

† Based on 0.5 lb. BOD per 1,000 square feet of water surface. Data for bulk tank varies, depending on whether pickup is every day or every other day.

‡ Because of extreme variations in cleanliness of cows and other conditions a range of load factors is not indicated.

Table 2. Data for planning sprinkler irrigation disposal.

Estimated volume (gal./day)	No. of sprinklers 5-gal./min. capacity	Pump size (gal./min.)	Operating time (min./day)	Plastic Pipe	
				Size* (in.)	Length† (ft.)
400	4	20	20	1½	160
600	4	20	30	1½	160
800	4	20	40	1½	160
1,000	6	30	33	2	240
2,000	8	40	50	2	320‡

* For steel pipe, use next larger diameter (1½-inch plastic or 2-inch steel).

† Length is that required for lateral sprinkler lines, and does not include main line from pump to disposal area.

‡ Two lines 160 feet long, spaced 60 feet apart, are better than one long line.

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